

***Interactive comment on “Technical note:
Measurements and data analysis of
sediment-water oxygen flux using a new
dual-optode eddy covariance instrument” by
Markus Huettel et al.***

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Review of “Technical note: Measurements and data analysis of sediment-water oxygen flux using a new dual-optode eddy covariance instrument.”

The manuscript submitted by Huettel et al. is appropriate as a technical note because it focuses on issues related to the quality of oxygen sensor measurements in the context of aquatic eddy covariance (AEC) measurements of benthic oxygen fluxes. The authors stress biases that can occur when sensors are affected by biofouling, and they

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illustrate with detailed examples how these artifacts can be recognized and controlled for using a dual-optode system. The examples are from an area of shallow shelf in the Florida Keys, making them unique environmentally. As a practitioner of these methods, I find this manuscript very useful, but I also recommend a number of revisions to improve clarity, especially for readers who may be less familiar with the AEC technique.

General recommendations: The manuscript is difficult to follow at times for reasons of organization and language. Most importantly, the introduction does not lead off with a very clear description of how biofouling or other “disturbances” can affect oxygen sensor measurements and corresponding AEC derivations. Instead the authors try to unravel these uncertain effects through the course of detailed reviews of data. More specific language throughout, as I will suggest below, would be helpful. Core questions are: does the biofouling produce or consume minute amounts of oxygen locally affecting what the sensor detects (sort of a contamination of the ambient condition), and why would this production or consumption be flow sensitive under waves? Zooming in to look at some data under both day and night conditions may help reveal the behavior.

It would also be helpful to simply refer to the three deployments used for illustration as something like “Case A, Case B and Case C”. The dates of the deployments were so similar, that a reader has trouble differentiating the examples by date alone.

Specific suggestions for edits:

Figures 2, 4 and 6 panels (b) units should be micromoles per liter. (Use consistent unit designations in tables and figures).

There is duplication of references: McGinnis et al. 2008a and b are the same, Reimers et al. 2012a and b are the same.

Line by line:

Page 1 lines 9-10: First example of a vague reference to the core problem “but a main weakness of the commonly used instrumentation is the susceptibility of the delicate

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oxygen microsensors required for the high frequency measurements to disturbances.” This needs to be rewritten. Might be best to say something like “but a critical requirement is that EC sensors are able to resolve high frequency variations in dissolved oxygen concentration and vertical velocity without artifacts.”

Page 1 lines 15-17. Revise. For example as: “Short-term changes in flux were confirmed or rejected with the 2OEC, giving more certain insights into the temporal dynamics of benthic oxygen flux in permeable carbonate sands.”

Page 1 line 18. Why do you say “within a couple of hours”? Do you mean that this is how much time is needed to capture a representative flux under steady conditions?

Page 2 line 36. Add: Reimers et al., 2016. Microelectrode velocity effects and aquatic eddy covariance measurements under waves. *J. Atm. Ocean. Tech.* 33, 263-282.

Page 2. lines 40-42. I question the statements: “Optodes consume no oxygen and have very low or no stirring sensitivity (Holtappels et al., 2015). Compared to microelectrodes, they are less susceptible to signal drift and keep their calibration over longer time.” It appears they may develop a stirring sensitivity once biofouled, and my experience is they may drift quite a bit due to their loss of sensitivity. Perhaps you could qualify these statements as: “Optodes consume no oxygen and may have very low or no stirring sensitivity (Holtappels et al., 2015). Compared to microelectrodes, we have observed they are less susceptible to signal drift and keep their calibration over longer time.”

Page 2. lines 51-54. Here is where the authors need to give a clearer initial description of how biofouling will alter signals from an optical sensor. The statement “through shielding of the sensor tip from the water current and metabolic processes (i.e. respiration, photosynthesis)” is unclear. What kind of changes in signal magnitude and dynamics occur and why? These things are rarely “obvious”, especially to new users.

Page 2. line 78. Revise as “is relatively robust compared to microelectrodes”...

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Page 2. line 80. If the discussion of sensor drift and lifetime is based generally on previous measurements, make this clear. If it is based on the experiments in this paper, move this reporting to the results section.

Page 5. lines 136-137. Revise as: “the product of instantaneous oxygen fluctuation and instantaneous vertical velocity change” or something clearer.

Page 5. lines 140-146. The use of a storage term here is not well justified and later on is not clearly discussed. Is this the correction referred to in Figure 3C? Holtappels et al. (2013) illustrate transient contributions to eddy fluxes linked to changes in C, but their model predictions of these effects are different from the storage term (although both are dependent on dC/dt). At the heart of the matter is: does oxygen change due to advection or due to localized cumulative production or consumption in the bottom boundary layer? You appear to assume a changing diurnal “storage” balance in dissolved oxygen, but the oxygen time series show other drivers of change. The statement given at lines 202-204 also indicates you recognize advection.

Page 6. line 168. Here you start referring to data processing steps as “corrections”. It would help the reader if section 2.3 separated these different corrections more clearly and let the reader know their effects on flux records would be evaluated as part of the results.

Page 6. line 172. It is not clear what the authors mean by “over the time course of the deployment”. Can they indicate over what time intervals the cumulative slope was evaluated? Did they assess the slope burst by burst, or over longer intervals? How is the standard deviation derived for these calculations?

Page 7. lines 216-218. A better explanation of the signal produced by biofouling under waves needs to be given. I have seen this effect in my data too. An oscillation develops at the wave frequency that appears to be greater than what would occur if the water column gradient was moving up and down or back and forth with wave motions. Looking at segments of the oxygen, velocity and pressure time series may help sort

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this out. It appears to be a “velocity effect”.

Page 8. line 236. Here you discuss another reason for poor sensor performance (particle impact). This should also be mentioned in the introduction under optode weaknesses.

Page 9. line 286-287. State more specifically how current measurements can be affected and why. Differentiate between real changes in the flow reaching the ADV sampling volume (flow obstruction) and measurement artifacts due to acoustic returns off the sensor tip.

Page 10. The paper conclusions are relatively weak. The authors could easily expand a bit on how the fluxes measured in this study compare to other inner shelf and coastal environments with permeable sediments, e.g. those of Berg et al. 2013.

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